

ELECTROSTATIC DISCHARGE TEST FOR VEHICLES

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. Scope—This SAE Information Report defines the test methods and specifications for the electrostatic discharge sensitivity of passenger cars, multipurpose passenger vehicles, trucks and buses.

2. References

2.1 Applicable Publication—The following publication forms a part of this specification to the extent specified herein.

2.1.1 IEC PUBLICATION—Available from International Electrotechnical Commission, 3, rue de Verambe, P.O. Box 131, 1211 Geneva 20, Switzerland.

IEC 801-2—ESD Coaxial Target

2.2 Related Publication—The following publication is provided for information purposes only and is not a required part of this document.

W. Sperber and R. P. Blink, Characterization of Electrostatic Discharge Generated by an Occupant of an Automobile, IEEE-EMC Symposium, 1987.

3. Definitions

3.1 Electrostatic Discharge (ESD)—A transfer of electrostatic charge between bodies at different potentials, occurring prior to contact or induced by an electrostatic field.

3.2 Human ESD Model—The capacity, voltage and resistance that characterize a person as a source of an electrostatic charge, for a particular set of surrounding conditions.

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4. **Equipment**

4.1 Electrostatic Discharge Simulator—The simulator shall be sufficiently portable for operation inside the vehicle compartment. The following characteristics simulating the human ESD model (Fig. 1) in vehicle operations shall apply (1):

- a. Voltage Range—Variable from –25 kV to +25 kV.
- b. Capacitor—Probes shall be provided for each of two capacitances:
150 pF and 330 pF ($\pm 10\%$)
- c. Resistance—2000 ohms ($\pm 10\%$)
- d. Inductance— ≤ 1 microhenry
- e. Rise Time— < 5 nanoseconds
- f. Tip—IEC Standard 801-2 (Figure 3)

The simulator shall be designed so that the discharge capacitance is fully charged to the desired voltage before the energy can be switched to the device under test.

Simulator equipment is commercially available.

5. **Test Vehicle**

5.1 Record the pertinent test vehicle information or any specific test conditions on a data sheet such as the example data sheet 1.

6. **Test Procedure**

6.1 Before the application of any discharges to the vehicle, the ESD Simulator Discharge Verification procedure of section 6 shall be performed.

6.2 Prior to performing ESD tests, a test plan shall be generated which will include all the interface test points and respective test levels for each interface to be tested; the vehicle modes of operation such as drive/idle, cruise; the number of discharges if different from that specified.

The 15/25 kV test levels shown in Table 1 are considered to be worst case but not unrealistic.

6.3 In a standard test sequence, the vehicle's engine is to be running in drive/idle mode. If the test sequence involves tests of systems at road speeds using a dynamometer (that is, cruise control), the speed will be defined by the requesting test engineer.

6.4 The ESD test simulator ground wire shall be electrically connected to the vehicle body inside the passenger compartment (see Figure 2). The steel seat adjustment rail or chassis is recommended.

6.5 The method of air discharge to a point in the passenger compartment shall be used to simulate a real world ESD event. With the simulator fully charged, approach the discharge point at a moderate rate (approximately 5cm/s) until a discharge is detected.

6.6 All discharge points shall be identified prior to performing a test. An example is data sheet 2, which is a partial list of discharge points.

- 6.7** All discharge points that can be accessed from inside the vehicle shall be tested with the 330 pF probe at 4000 and 15 000 V through 2000 ohms. Only those discharge points that can be conveniently accessed when standing outside the vehicle (this in effect lowers a person's capacitance) and reaching inside, such as the headlight switch or the ignition switch, shall be tested with the 150 pF probe at 25 000 V through 2000 ohms. This distinction shall be at the discretion of the test engineer. Any other discharge point not listed on data sheet 2, but deemed pertinent to this test, shall be included. These points shall, at a minimum, include all electrical switches and controls that can be interfaced by an occupant within the passenger compartment. Also any knobs, levers or handles which would be actuated in the normal operation of the vehicle should be included.
- 6.8** Each discharge point shall be subjected to a minimum of three positive polarity and three negative polarity discharges at each voltage level. The time duration between discharges shall be a minimum of five seconds. Table 1 gives a summary of the test parameters.
- 6.9** Visual, audible and instrumented deviations from normal vehicle operation will be entered into the data log. Various operating systems such as heater controls, air conditioner controls, radio controls, and digital displays will be exercised periodically during the test to demonstrate normal response.

7. ESD Simulator Discharge Verification

- 7.1** This section defines a test method for verifying the operation of the ESD Simulator.

7.2 Equipment for Verification

- 7.2.1 GROUND PLANE**—The ground plane shall be a conductive metallic sheet (copper or aluminum) 0.25 mm thick, with an area of at least one square meter. The ground plane shall be connected to the facility earth ground by a braided strap which should be less than 1 m long and at least 1 cm wide.
- 7.2.2 COAXIAL TARGET**—A 50 ohm coaxial target is defined by the International Electrotechnical Commission (IEC) Standard 801-2 (see Figure 4). The target shall be bonded to the center of the ground plane defined in 7.2.1.
- 7.2.3 20 DB ATTENUATOR**—A 50 ohm, 20 dB, wideband attenuator is to be attached to the output of the coaxial target.
- 7.2.4 MEASUREMENT INSTRUMENTATION**—A measurement device with a minimum bandwidth of 250 MHz (1 GHz bandwidth preferred) and a 50 ohm input impedance shall be used. (An analog oscilloscope is preferred. If, however, a sampling oscilloscope is used, an instrument having a digitizing rate of 1 Giga-samples per second may be required to provide a reliable 250 MHz single-shot bandwidth.) The measurement instrument may have to be shielded against electromagnetic interference.
- 7.2.5** The ESD Simulator shall be verified using a meter (or oscilloscope). The probe used must have a high impedance (100 Megohm minimum).

7.3 Verification Procedure

- 7.3.1** The test setup shall be configured in accordance with Figure 5.
- 7.3.2** The coaxial target shall be located on and bonded to the center of the ground plane.
- 7.3.3** The horizontal time base and vertical amplifier level of the measurement instrument shall be set as necessary to enable viewing of the complete ESD waveform. The horizontal sweep shall be set to single event trigger. (If a Giga-samples per second digitizing oscilloscope is used and the bandwidth of the vertical amplifier is greater than 250 MHz, use an anti-aliasing filter.)

- 7.3.4 The ESD Simulator high voltage ground shall be directly connected to the ground plane defined in 7.2.1. The ESD Simulator shall be set up and turned ON per its instruction manual.
- 7.3.5 The ESD Simulator shall be adjusted to the desired voltage (V_s) and polarity. Using the meter and probe defined in 7.2.5, verify the simulator voltage/polarity setting.
- 7.3.6 The ESD Simulator probe shall be placed a fixed distance of 0.51 mm from the coaxial target sphere when calibrating a 4 kV and at 2.54 mm when calibrating at 15 kV. The Simulator fingertip probe shall be held perpendicular to the coaxial target. The Simulator should then be triggered. If a discharge does not occur (due to humidity effects), shorten the distance between the simulator probe and coaxial target until a discharge does occur.
- 7.3.7 The waveform shall be reviewed and its key parameters analyzed. Figure 6 shows the typical waveform shape. As illustrated in the figure, the measured waveform may contain a high speed, leading edge transient.
- 7.3.8 Only single event discharge waveforms are acceptable.
- 7.3.9 Acceptable ESD waveforms shall be repeatable 6 times minimum in 10 attempts.
- 7.3.10 Record the waveform parameters and shape on the data sheet in Figure 7. The RC time constant is determined from the discharge curve at the point where 63% of the waveform has decayed.
- 7.3.11 Verify that the rise time and RC values meet the requirements of 4.1.
- 7.3.12 Repeat the above calibration procedure for each test voltage level and each polarity.

HUMAN ESD MODELS FOR VEHICLE TESTING

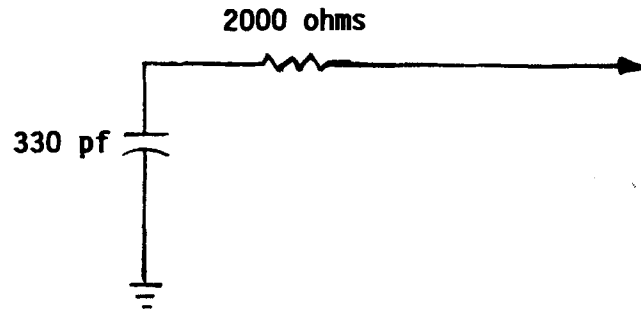


FIGURE 1a - Inside Vehicle Parameters

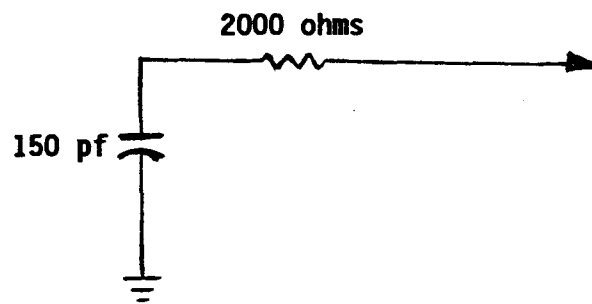


FIGURE 1b - Outside Vehicle Parameters

FIGURE 1—HUMAN ESD MODELS FOR VEHICLE TESTING